WORCESTER
Historical Museum

DESIGNING AN INTERACTIVE SMILEY FACE CART AS A FAMILY-FRIENDLY MOBILE EXHIBIT

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ABSTRACT

With the intention of educating people on Worcester history and spreading the joy of the Smiley Face, Worcester Historical Museum (WHM) has proposed to develop a Worcester history and Harvey Ball-themed, mobile exhibit that will be used by the museum in Elm Park and other surrounding locations for Harvey Ball's 100th Birthday and future events. Therefore, the goal of our project was to establish the learning outcomes of the Smiley Cart, determine the most popular and appropriate take-aways, design activities for a family-friendly mobile exhibit, and create a design for the Cart. Through a series of interviews, focus groups, and surveys, we developed a Smiley Cart design in SolidWorks and a plan for the interactive learning activities.

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CREATING A MOBILE EXHIBIT FOR WORCESTER HISTORICAL MUSEUM

In 2016, a man was in the Orange County Airport waiting for his plane from Disneyland to San Francisco. A group of people, both men and women in their 30's or 40's, were leaving a conference. One of the women in the conference started complaining about one of her colleagues, saying "I wish I had a Smiley Face button! I'd tell him where to put it! He is so miserable!" The man then reached into his zipper pocket of his carry on and said to the women, "I didn't mean to eavesdrop, but here's a Smiley Face button," sparking a conversation about the history of Smiley Face and what it means to Worcester, Massachusetts. They talked until their flights departed. That man was William Wallace, the executive director of the Worcester Historical Museum (WHM) (William Wallace, personal communication, February 18, 2020).

The Smiley Face is something that everyone knows of, but also something only a few know about. For example, someone drawing Smiley Face doodles in their notebook or using the Smiley Face emoticon in a text, may not know the origins of the Smiley Face and why it is so important. This is where museums can play a role.

The Worcester Historical Museum has been keeping the history of Worcester alive through its exhibits and events. The Museum's exhibits tell stories about the city throughout history. Additionally, the Museum holds events such as The Harvey Ball, which is a charity function held in honor of Harvey Ball (Worcester Historical Museum, n.d.). As illustrated by Mr. Wallace's airplane conversation, the story of Harvey Ball resonates with people. To share Harvey Ball's story and in celebration of Harvey Ball's 100th Birthday, Mr. Wallace has reached out to Worcester Polytechnic Institute.

In collaboration with WHM, we worked to design a family-friendly, interactive, mobile exhibit, Smiley Cart, to distribute the iconic smiley buttons (pins) and to educate the public about Harvey Ball while bringing smiles to the community. Mr. Wallace envisioned a Smiley Cart that tells the story of Harvey Ball and hoped it would lead to addressing the lack of knowledge about Harvey Ball and his Smiley Face design and a lack of willingness to learn about local history. To achieve our goal, we explored past museum exhibits, design processes, and the Worcester community and its history.

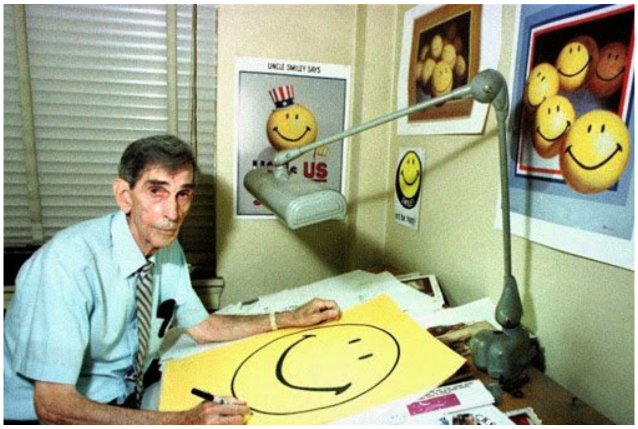

Figure 1: Harvey Ball and the Smiley Face (Worcester Historical Museum)

DESIGNING MUSEUM EXHIBITS

Successful exhibits go through cycles of testing and redesign to improve over time (Lisney et. all, 2013) and there are a few things that have been proven to help almost all museum exhibits. In a study conducted by Minda Bourne and Philadelphia/Camden Informal Science Education Collaborative (PISEC), they identified seven characteristics of a family-friendly exhibit, see Figure 2, below.

These characteristics represent the goals of all family-friendly exhibits, but how do curators decide if an exhibit is effective or not? The American Association of Museums' Standards for Museum Exhibitions (Association) offers some guidance. The Association describes a successful exhibit as one that "is physically, intellectually, and emotionally satisfying to visitors" (Carliner, 2001). While PISEC's characteristics is a guidance on how to structure and display family friendly exhibits, the Association's guidance mainly focuses on if the visitor enjoys the exhibit. When we combine the two, we get both sides of designing an exhibit, the format and the actual content of the exhibit.

Capturing the attention of the target audience is done by making a personal connection between the information and the visitor. A study done in Aarhus, Denmark at the Steno Museum offers another way to look at how to design a museum exhibit that is effective in creating visitor reflection and discussion. The Steno Museum identified four design principles for exhibit development to achieve an effective exhibit. The four principles are curiosity, challenge, narratives, and participation (Skydsgaard, 2016). According to Skydsgaard, curiosity allows people to relate their existing knowledge to the new material. Making the exhibit challenging provokes thought and strong reactions to the auidence making them engaged. He also says that the way the story is told directly reflects the fundamental way the audience learns. Studies show that the narratives from members of the same target group helps increase the connection a person feels to the exhibit and how invested they become. It is important that an exhibit encourages both physical and dialogical interactions. Physical engagement has been linked as forms of active listening and the physical processes of informing understanding. Participating dialogically is linked to absorbing new knowledge. This allows people of all ages to make meaning and share ideas (Skydsgaard, 2016). The Steno Museum's criteria incorporates both PISEC and the Association's criteria for exhibit design with an extra emphasis on the way the content is presented, how the

Combined Characteristics	**Description**
Multi-sided	"family can cluster around the exhibit"
Multi-user	"interaction allows for several sets of hands (or bodies)"
Accessible	"comfortably used by children and adults"
Multi-modal	"appeals to different learning styles and levels of knowledge"
Readable	"text is arranged in easily-understood segments"
Relevant	"provides cognitive links to visitors' existing knowledge and experience"

Figure 2: Philadelphia/Camden Informal Science Education Collaborative's (PISEC) seven characteristics of a family-friendly exhibit (Borun & Dritsas, 2010, p.180)

story is told. Figure 3 shows a comparison of the three approaches of designing exhibits, Figure 4 shows the combined guidelines we used for exhibit design, and Figure 5 shows a comparison of each criteria against the combined guidelines.

The importance of designing an exhibit around a target audience is crucial to creating an effective exhibit that meets PISEC's, the Association's, and Steno Museum's criteria. In a 2010 survey of 42 children's museums, the study revealed that the majority of groups who visit children's museums are families with children. Given this, it is important to find a way that allows all family members, not just the kids, to access and enjoy the exhibit. The field of children's museums has changed with the widespread recognition that a key audience of the visit are adults (Mortati, 2010). Adults serve as the children's guide, showing them through the museum and talking them through exhibits. This is not to say that the adult takes control, but rather the extra push allows children to develop their own interests (Mayfield *, 2005). Adults are also the main reason the children are visiting, and needless to say, may rush through the museum if they are not enjoying it as well. To prevent this, many museums added activities for adults, such as content for them to read (Mortati, 2010). Interactivity is the most effective way to keep children entertained and educated, while at the same time there is new and interesting information for adults to be learning as well (Borun & Dritsas, 2010).

Interactive Exhibits

Interactive exhibits can take on a lot of different shapes and sizes. For the purposes of this project, we use PLB's, a museum design consultant firm, definition of interactive, meaning exhibits that have activities or props the audience can interact with (PLB Projects Ltd, 2019).

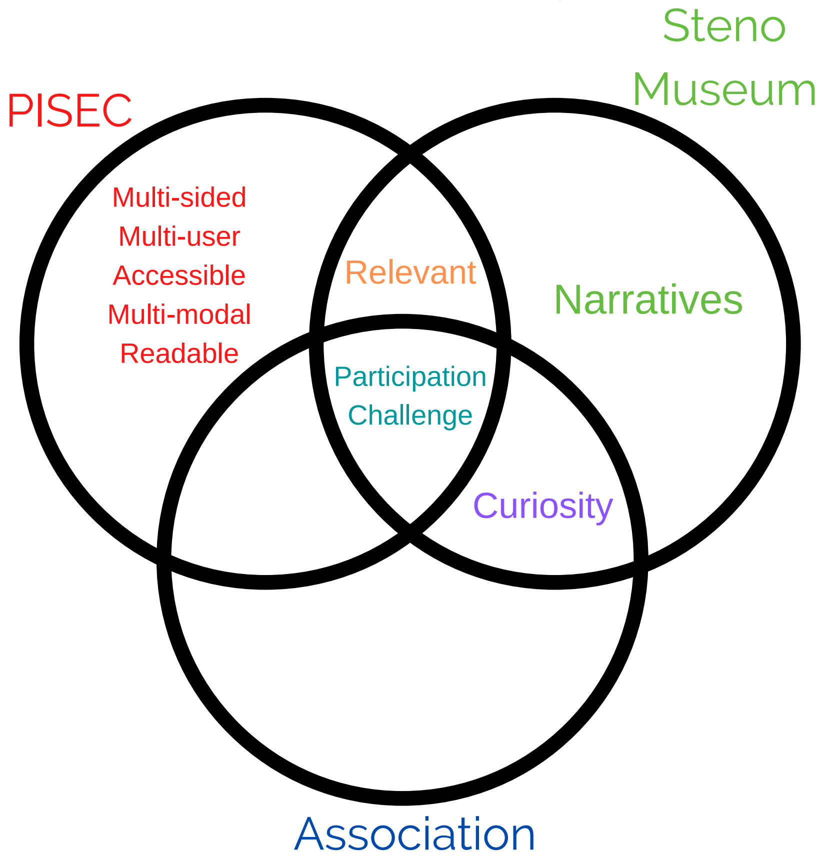

Figure 3: Venn Diagram comparing PISEC's, the Association, and the Steno Museum's criteria for exhibit design.

Museums are trying to take a more interactive approach to exhibits as it helps visitors learn and stay more engaged. In 1997, the Hunt Museum in Limerick held an experiment to see if interactive exhibits were worth investing in. The curators designed a set of Cabinets of Curiosities. Inside of these cabinets were drawers or doors where visitors could open and get closer to the artifacts inside to get a better understanding of the story. Since the common stereotype in museums is to not touch anything, the audience was not used to the idea of opening the doors and seeing the content inside. However, according to Csiszentmihaly and Hermanson the experiment resulted in a higher rate of visitor enjoyment (Ciolfi & Bannon, n.d.).

In 2021, museums are taking the interactive element to heart and can be seen in all styles of museums. For example, science museums try to make exhibits fun and interactive for all members of a family. By appealing to all age groups, museums are able to draw a larger audience. For example the Boston Science Museum's 2021 Arctic Adventure exhibit allows the visitor to be an active participant and become an Arctic researcher. The exhibit uses a combination of physical features and software to give the user the feeling that they are a real Arctic explorer. To make it even more special they made sure that every time the season changes, so does the experience (*Arctic Adventure Interactive Exhibit Features*, 2021).

An example of a history museum incorporating interactivity is the Worcester Historical Museum. WHM, in collaboration with Worcester Polytechnic Institute students, designed a historically themed portable miniature golf course. The students included many interactive and engaging parts to the design, such as a spinner with challenges (ex: putt with one hand) and obstacle courses you must overcome. Each hole also aimed to teach the audience something about Worcester, such as

Combined Characteristics	Description
Multi-sided	"family can cluster around the exhibit"
Multi-user	"interaction allows for several sets of hands (or bodies)"
Accessible	"comfortably used by children and adults"
Multi-modal	"appeals to different learning styles and levels of knowledge"
Readable	"text is arranged in easily-understood segments"
Relevant	"provides cognitive links to visitors' existing knowledge and experience"
Curiosity	Visitors want to engage with the materials presented
Challenge	Brings out strong reactions, emotions, or provokes thought
Participation	Intrigues both physically and dialogically
Narrative	Story is told in a way that the audience can be invested in and learn from

Figure 4: Combined criteria of exhibit design.

a floor with the world map printed on it, indicating that Worcester is a diverse city (Aiello et al., 2013). Throughout the 19th-21st centuries, interactive museums and exhibits are becoming more popular to try to draw in a bigger audience into the museum.

Mobile Museums

Interactive exhibits have evolved with "outside the box approaches," in 1967, Malraux proposed “the museum without walls,” a concept that creates a non-fixed space, compared to the traditional fixed space museum, which limits what can be done for exhibits. “The museum without walls” aims to minimize the distance between culture, artistic events, and the audience. This concept revolutionized modern museums and from it, emerged virtual museums, wall-less museums/invisible museums, and mobile museums. Originated in the mid-19th century, mobile museums are user-friendly and display works on highly-mobile vehicles, such as trucks, buses, and trains. This concept can be adapted to all museum categories, such as art, cultural, historical, and scientific (Huang et al., 2018).

According to Huang et. al, we can change the audience’s fixed notion of museums if we bring the museum’s wonders to daily life. Having mobile museums in neighborhoods and familiar areas can change the audience’s impression on museums and reduce the tension, nervousness, transportation challenges, and stereotypes of museums. Mobile museums also changed the marketing game by reducing the pressure of long-term maintenance of permanent sites (Huang et al., 2018).

In 2017, the National Museum of Taiwan Literature with help from Taiwan University of Technology (TU), created the Mobile Museum of Taiwan Literature (MMOTL). The Taiwan Literature Museum and the University combined technical innovations to curate the mobile

Combined Characteristics	PISEC	Association	Steno Museum
Multi-sided	✓		
Multi-user	✓		
Accessible	✓		
Multi-modal	✓		
Readable	✓		
Relevant	✓		✓
Curiosity		✓	✓
Challenge	✓	✓	✓
Participation	✓	✓	✓
Narrative			✓

Figure 5: Comparative table of all exhibit design criteria.

museum. Using a 40-foot cargo truck, they implemented Augmented Reality (AR), video, and animation to turn it into a 3D interactive exhibit that embodies the beauty of Taiwan literature. By scanning a QR code to download an app on your phone or tablet, visitors can scan the images on the truck and the book collection of the author will appear on the phone or tablet. The MMOTL also offers a local writer's book fair for visitors to read and enjoy after interacting with the exhibit (Huang et al., 2018).

Through testing their exhibit on the streets, TU discovered that the audience was surprised to see static literature combined with AR technology and began to share this newfound knowledge. They also realized that the mobile exhibit must adapt to each location for visitors to get the most out of the exhibit as in some areas people will have different levels of knowledge. This will also bring a more personal aspect to MMOTL, so the audience can feel a connection to the exhibit. MMOTL traveled around Taiwan many times throughout the years and has expanded the audience's understanding of culture (Huang et al., 2018). It allowed the community to connect and share with each other.

As seen in Figure 6, almost all exhibits brought up in this report hit all combined criteria of exhibit design. Each exhibit has the same goal of expanding knowledge in a fun and interactive way in mind, but did so in different ways. For example, the MMOTL's main goal is to spread the knowledge of Taiwan literature and public sharing. It would seem the WHM golf course's main goal is just to create a mini-golf course at first glance, however, you can see their main goal is also to spread knowledge, but the knowledge of Worcester and Worcester history. The student's accomplished their goals in a different way than the MMOTL, although both engaging, the students did it through a mini-golf game, rather than a truck with AR.

Combined Characteristics	**Cabinets of Curiosities**	**Arctic Adventures**	**MMOTL**	**WHM Golf Course**
Multi-sided	✓	✓	✓	✓
Multi-user	✓	✓	✓	✓
Accessible	✓	✓	✓	✓
Multi-modal		✓	✓	✓
Readable	✓	✓	✓	✓
Relevant	✓	✓	✓	✓
Curiosity	✓	✓	✓	✓
Challenge	✓	✓	✓	✓
Participation	✓	✓	✓	✓
Narrative	✓	✓		✓

Figure 6: Comparing the MMOTL and the WHM golf course exhibit to the combined criteria of exhibit design.

Evaluating Exhibits

In order to gauge if a newly designed exhibit is successful in engaging and teaching the target audience, exhibit designers must have methods to indicate the exhibit's achievements and failures. In an analysis of 493 family interactions at 25 different children's museum exhibits to determine the best methods for evaluating exhibits, one method to measure the exhibit's success is to look at the audience's time spent (how much time families spend at an exhibit), exhibit engagement (how they engage with exhibit elements), and interpretive talk (how families talk together during exhibit activities). Comparing these individually, the three measures were not highly correlated, this suggested that a single indicator is insufficient. By evaluating these measures simultaneously, one will be able to gage the interactiveness of an exhibit. This helps "evaluators begin to explore the relationships between families' learning behaviors, and think about how exhibit characteristics can influence potential learning opportunities in informal settings" (Sanford, 2010).

According to a study by Liu, another way to gauge if the exhibit is successful is conducting semi-structured interviews and surveys. After the audience viewed a heritage site for the application of digital display technologies in Taiwan, conducting interviews and surveys was the best method to gauge the audience's engagement. Through the interviews and surveys, Liu found that digital display technologies received high acceptance from visitors and had a positive impact on encouraging their exploration, learning, visualizing, and creating new experiences of perceiving, engaging, and communicating with history (Liu, 2020), something that the Worcester Historical Museum aims to do.

Worcester Historical Museum and Harvey Ball

In 1875, a man named Samuel E. Staples (1822-1902), conjured up an idea to preserve and tell the story of the past. Staples "…proposed to form a Society for the purpose of increasing an interest in Archaeological Science, and to rescue from oblivion such historical matter as would otherwise be lost…" The Worcester Society of Antiquity was born from this meeting and would later be known as the Worcester Historical Museum (WHM) ("Museum History," n.d.). The society grew rapidly and gained many galleries and exhibitions. Today, WHM stands at 39 Salisbury Street to 30 Elm Street. ("Museum History," n.d.).

WHM tells Worcester's history as a story through permanent and changing exhibitions, educational programming, tours, publications, and hands-on activities for all ages. Some examples of WHM's exhibits are correspondence of Abby Kelley Foster, Civil War era diaries, and artifacts related to Worcester's industrial past (Worcester Historical Museum, n.d.-b). One of WHM's most notable exhibits is their Smiley Face exhibit where the iconic story of Harvey Ball is told.

Harvey Ball was born in 1921 and raised in Worcester, MA (World Smile Foundation, n.d.). During his time at South High Community School, Ball gained an apprenticeship with a sign painter where he learned how to create strong visual images and then won a scholarship to the Worcester Art Museum School. Ball then worked for an advertising agency until he started his own business, "Harvey Ball Advertising'' (Worcester Historical Museum, n.d.).

In 1963, State Mutual Life Assurance Company of America was facing morale problems as it expanded. The company decided to hire Harvey Ball to create a campaign to improve morale. Ball then created The Smiley Face as the symbol for the company's campaign (*World Smile Foundation*, n.d.). In 1960-1970, the Smiley symbol was claimed to have been made by others, but the design has been well documented in Harvey Ball’s authorship. In 1964, The Smiley Face was printed on 100 buttons to give to the company's representatives, which successfully raised morale. For the next 14 to 15 years tens of thousands more buttons were ordered before the symbol was retired. Ball happily continued his graphics work in Worcester until he passed in 2001 (*Worcester Historical Museum*, n.d.).

FOUR STEPS OF EXHIBIT DESIGN

We developed four objectives to achieve our project goal-- to educate the public of Worcester's history of Harvey Ball and his creation of the Smiley Face through a family-friendly, interactive, mobile exhibit. See Figure 7, below, for a summary of the objectives and methods. Throughout this report "Smiley Cart" and "Cart" will be used interchangeably and both terms include the mobile and interactive components of the Cart design, from the material and layout of the Cart to the activities within the Cart.

Objective 1: Determine Learning Objectives of the Exhibit

To determine the learning objectives, we conducted interviews with a variety of stakeholders. A learning objective is the goal of knowledge that a person should gain from an exhibit (Corriveau et al., 2013).

On Wednesday February 17th, 2021, we conducted a semi-structured interview with William Wallace, the Executive Director of the Worcester Historical Museum (WHM). Mr. Wallace is an important person to interview because, not only is he the Executive Director of WHM, he is also passionate that Harvey Ball receives the recognition he deserves. WHM's interest in initiating this project is to educate the public about Harvey Ball's presence in Worcester and his creation of the iconic Smiley Face.

We learned through this interview that Mr. Wallace wanted the exhibit to be engaging, accessible to people of all ages and backgrounds, and result in visitors knowing the story of Harvey Ball. In order to determine the learning objectives, we conducted two additional interviews with teachers from the Worcester Public School system. Interviewing Worcester Public School teachers allowed us to make sure that the learning objectives are achievable by people of all ages and educational backgrounds. Additionally, they shared their knowledge of how to engage children so they are excited to learn about Worcester and Harvey Ball.

Project Objectives

1. Determine Learning Objectives for the Exhibit	2. Identify the Target Audience	3. Determine Smiley Cart Design Components	4. Design the Smiley Cart Based on the Components
• Interview Sponsor and Worcester Public School Teachers	• Interview Sponsor • Research Museum Demographics	• Interview • Focus Group • Survey • Research materials and articles about family-friendly, interactive exhibits	• Brainstorm • Evaluate • Design using SolidWorks

Figure 7: Summary of our objectives and methods.

Objective 2: Identify the Target Audience

To determine who WHM and Mr. Wallace wanted the exhibit to be geared toward, we conducted the interview described in objective 1 (see above). We learned from Mr. Wallace that the exhibit should not only be accessible and engaging, but also be family-friendly. A family-friendly exhibit is one that is able to be enjoyed by adults and children alike (Family-friendly, n.d.). This means it must be interactive (exhibits with activities or props the audience can interact with) and interesting to all age groups. Based on the criteria from Mr. Wallace, our target audience included everyone: children and families, grandparents, and single adults. To achieve being family-friendly, we followed the combined criteria of exhibit design established in Figure 4 of the “Designing Museum Exhibits” section. Using the information on target audience and learning objectives, we developed design strategies for the Smiley Cart.

Objective 3: Determine Smiley Cart Design Components

Our sponsor, Mr. Wallace, and the Worcester Historical Museum provided us with a rough outline of what they wanted in the Smiley Cart. This gave us a jumping off point from which to research. According to Mr. Wallace, in addition to the learning outcomes, WHM’s criteria for the Cart included a power source, portability, and the ability to engage the target audience in an activity. WHM asked for the Smiley Cart to have a flat surface, a place for storage, trash disposal, be able to be pedaled from location to location, have some sort of power source, lights, be durable, and most importantly have a big, bright, yellow Smiley Face umbrella. Additionally, we knew the Cart must be family-friendly. So by following the combined criteria of exhibit design in Figure 4, we were able to complete this key aspect of the Cart.

Our first step was to determine how to engage the target audience in an activity and what activities would be best to engage them in. We interviewed our sponsor, two Worcester Public School liaisons, and exhibit designers/museum staff at the Worcester Art Museum, the Acton Discovery Museum, the Ecotarium, the Russian Museum of Icons, the Portland Museum of Arts, the USS Constitution Museum, and the Portland Children’s Museum to gain their insight on how to make exhibits engaging and exciting for the audience. During the interviews, we asked the curators questions about strategies or ideas they have used that worked well to engage groups of all ages (see Appendix A for more questions). We also conducted two focus groups with Worcester Public Schools students from Art Reach to help us explore engaging, family-friendly exhibit design ideas from a child’s perspective. More specifically, we conducted two focus groups which consisted of children ages 7-10. For focus groups, we had one group member serve as the facilitator and one member take notes of the meeting (see Appendix D and E for focus group questions and Parental Assent Form). We also developed a survey of potential family-friendly design approaches for the Smiley Cart and distributed it to Worcester Polytechnic Institute (WPI) students and staff, Worcester Public School teachers, parents, and WHM staff (see Appendix C for the survey questions). We evaluated the best options for activities and design approaches using a comparative matrix to compile all data collected from the interviews, focus groups, and survey. For ease of analysis, we compiled the results and organized them by topic/theme.

The second potential interactive element was a tablet. Our team was inspired by the Mobile Museum of Taiwan Literature to explore the option of using QR codes to play the video, slideshow or potentially a game with a prize at the end (Huang et al., 2018). We did further online research to explore the use of QR codes; how to set one up, what kind of content they can be used for and whether the target audience is adept at using QR codes. We also sought the Art Reach director, the Worcester Public School teachers and family-friendly exhibit designers input on using QR codes and tablets during the interviews.

Our second step to accomplish this objective was to determine the viability and utility of a power source and how to make the Smiley Cart portable. According to Mr. Wallace, a power source could be used for a tablet, lights, and/or an electric bike. We conducted online research on the most efficient and cost-effective pre-fabricated carts that had a power source and bike-peddled options. By efficient, we mean in terms of giving the most power for the longest period of time. By cost-effective, we mean which pre-made cart will cost the least while still being efficient. Here, it is a balance between cost and power strength. We considered aspects of the pre-fabricated carts, such as material, if it was a good fit for the activities we wanted on it, how customizable it was, and how long it would take the company to make the Smiley Cart. with a Budget-Cost (B/C) analysis on the options to determine cost-effectiveness. We spoke with each company for a better understanding of their pre-made carts.

Identifying what engages the target audience was an essential part of the Smiley Cart. Being able to engage the audience will have a better effect on the overall experience for both WHM and its visitors.

Objective 4: Designing the Smiley Cart by Incorporating Identified Components

Using the components determined in Objective 3, we designed the Smiley Cart to produce the most effective combination of engagement and learning possible. We designed both the structural components of the Cart and the interactive, engaging mobile components of the Cart. For designing the Cart, we each sketched out our initial ideas on paper, in Microsoft paint, and in SolidWorks, a Computer Aided Design (CAD) program, and compiled them into a document. CAD programming allows us to develop a scaled prototype and get a better visualization of the Cart. The scaled model also allows for easy fabrication of the Cart. Once we picked which pre-made cart was best, we modeled our design based on that cart in SolidWorks.

During our interviews with stakeholders experienced in design, we presented this work to gain their feedback. Compiling all the feedback into a comparative matrix, we evaluated which elements from each design worked and didn’t work and what we needed to add. We worked together on a whiteboard on one final design to compile all the feedback we received. We then transferred the final design into SolidWorks for reference and documentation.

The process of designing an exhibit is recursive. In order to develop an exhibit that met Mr. Wallace's expectations and achieved our project goal, we needed to focus on stakeholders input and the target audience's response. To ensure our design meets WHM’s expectations for the exhibit, we brought our final SolidWorks design plans to Mr. Wallace and WHM staff for evaluation. Then we redesigned the Cart based on their inputs. Normally this process takes years to develop a succinct design, however due to time constraints we were only able to go through this process three times. Figure 8 illustrates our design process.

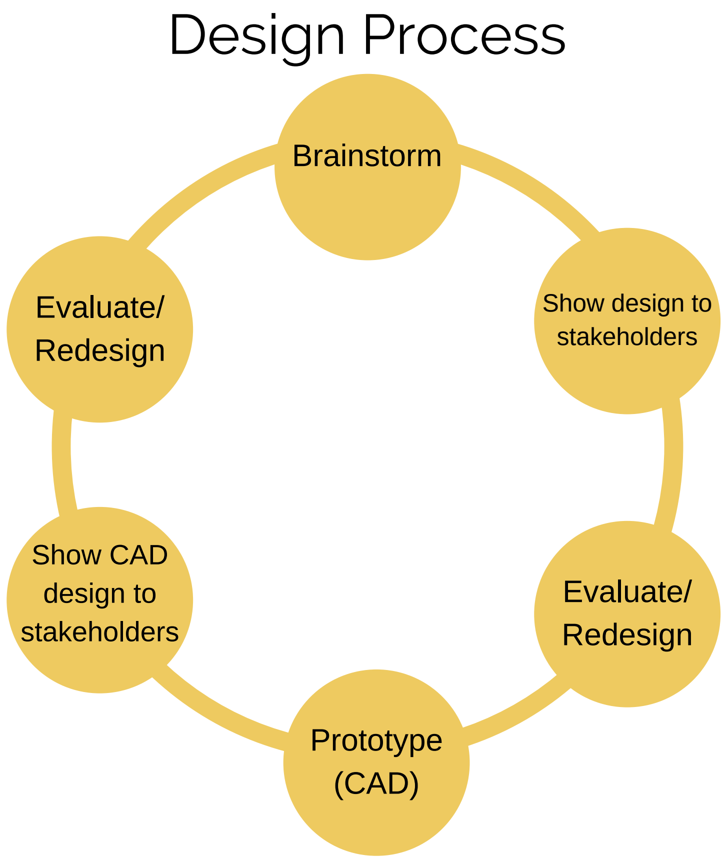
Design Process
Brainstorm
Show design to stakeholders
Evaluate/ Redesign
Prototype (CAD)
Show CAD design to stakeholders
Evaluate/ Redesign

Figure 8: Design process of the Smiley Cart.

PROPOSED SMILEY CART DESIGN

As a result of our research, we developed a Computer Aided Design of the Smiley Cart and family-friendly activities to be used with the Cart. The design features both entertainment and educational aspects. This allows WHM to be impactful and accessible in daily Worcester activities by increasing WHM's presence in the city. The final design of the family-friendly, interactive, mobile Smiley Cart is shown in Figure 9 and our early designs can be found in Appendix F. For the sides of the Cart, we designed them in a way where they would be functional as well as aesthetically pleasing. The Harvey Ball timeline is featured on the longest side of the Cart. On the front we have the WHM logo to emphasize the association of the Smiley Cart with WHM. Quick response codes for the Smiley Face song and I-Spy game are featured on the corner diagonal panels of the Cart. Lastly, the iconic Smiley Face is displayed on the bright, yellow umbrella. We discuss the design features in more detail below.

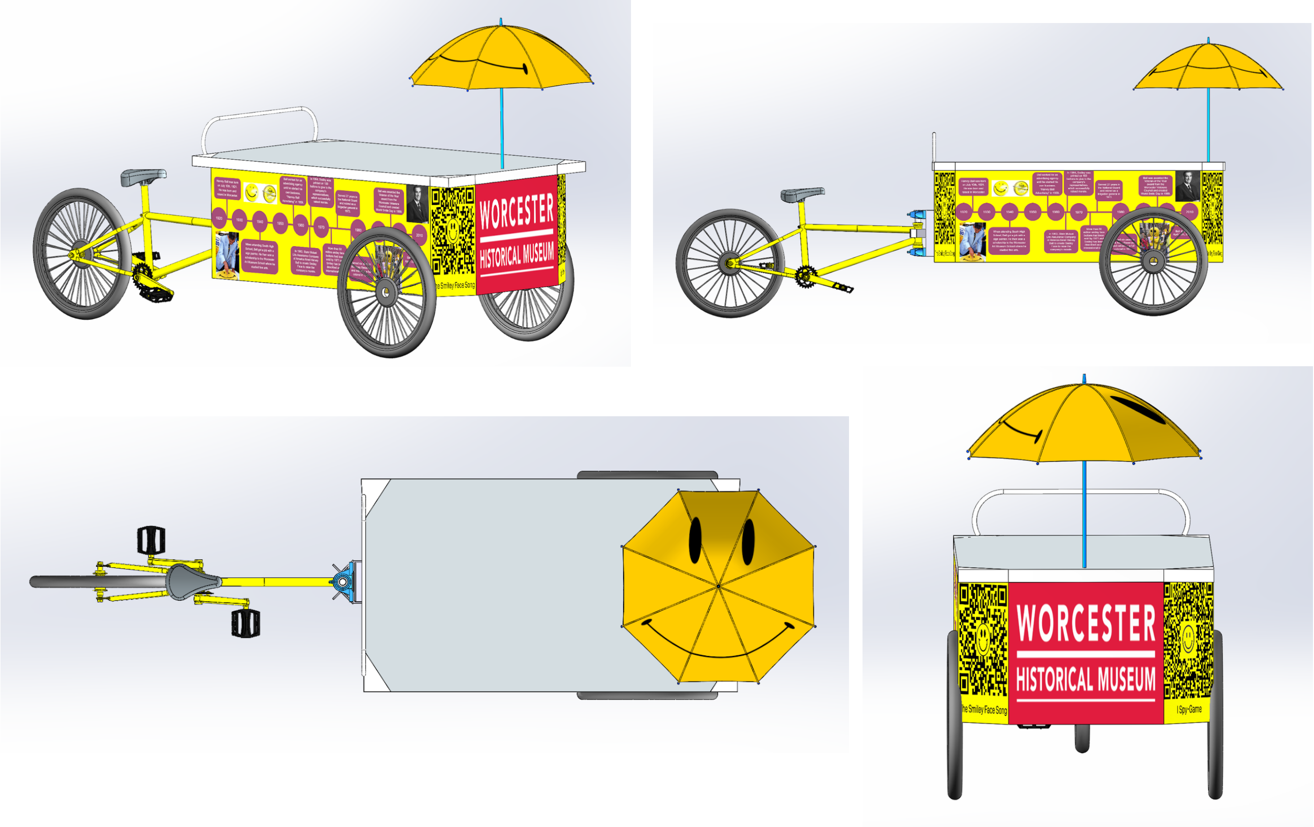

Figure 9: Pictures of the concept design for the Smiley Cart features a Smiley Face umbrella, Harvey Ball timeline, and QR codes for the Smiley Face song and I-Spy game.

Structure of the Cart

We recommend WHM use a prefabricated cart for its Smiley Cart due to the expertise of these companies, the low cost, and convenience. Prefabricated carts are able to be customized to the customer's desire and to offer a way for the customer to get everything in one place, from the bike, motorized kit, and lights, to shade coverings, custom wraps/decals, and extra add ons, such as a sink. It saves the hassle of looking for each individual part separately and wondering what materials would be best suited. With the time restraint of having it up and running for the summer, in a discussion with WHM it was recommended we start to look into premade carts to use as a starting point. Also by using a Prefabricated cart we were able to get help from a company to build and design. The companies which make prefabricated carts share their knowledge and assist the customer to what is best for the function and design of the cart.

We started off looking at a wide variety of different carts and started to narrow them down with the help of WHM. We eventually came up with a list that had 3 different carts in it coming from 2 different companies. The first company was BikeAndABox producing both the Original E-Bike and the Raptr2. The second Company is Bizz on Wheels with their Basic Vending Cart. A full comparison of all 3 carts can be seen in Appendix G. We decided to go with the Raptr2 bike. This decision was made based on a few major factors. For the Original E-bike the main reason it was ruled out was that it was out of stock when we got ready to order it which would make it should that we could not get it in time for when WHM wanted it. The Basic Vending bike by Bizz on Wheels was ruled out because the lack of communication we were getting from them and with them located out of the country meant that it would be harder to receive it and harder to communicate with them.

Some general information about the Raptr2's bike that we went with is that dimensions are 24" high by 49" wide and 50.5" long. It has a storage space that can be accessed from the front or back that spans the whole length of the cart and has one drawer on it. It also can be separated into a push cart to be pushed by hand if ever taken inside a classroom in a school or into WHM for people to experience it. They are willing to customize it to have a canopy or umbrella in the yellow color that we want and add a trash can to it for us. The frame is made out of carbon Steel. The Raptr2 can be seen below, in Figure 10, in two different angles of the cart.

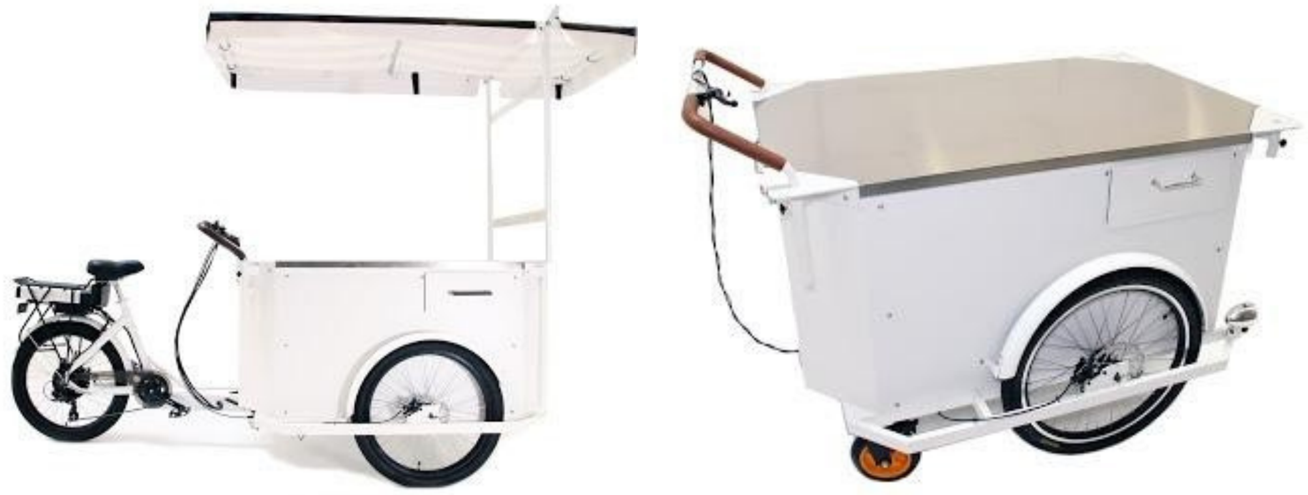

Figure 10: Pictures of Raptr2 provided to us by Bike and a Box, see Appendix P for Copyright approval.

Interactive Components

By analyzing the data collected from 12 interviews, focus groups, and 162 survey responses, we identified eight findings (all bolded) and for each finding, provided a recommendation for the Worcester Historical Museum's (WHM) Smiley Cart. Appendix Q outlines the makeup of our survey respondents. Our findings either validate or enhance the numerous exhibit design approach criteria we learned about during our background research, such as Philadelphia/Camden Informal Science Education Collaborative's (PISEC) seven characteristics of a family-friendly exhibit, The American Association of Museums' Standards for Museum Exhibitions (Association), and the Steno Museum's four principles for exhibit design. A summary of our findings and how many interviewees spoke to them is shown in Figure 11. Please note, interviewees were not asked specifically about each topic below and some topics were not mentioned in some interviews due to time restrictions or other factors. Appendix B contains a comparative matrix of our findings.

Fundamental Recommendations

The goal for all exhibits is for the audience to feel welcomed and comfortable, like they are in their own home. Ten out of the 12 interviews noted that having an inviting and approachable exhibit will make visitors feel comfortable to explore the exhibit/museum on their own path. Amy Freesun the Interpretation/Community Collaboration Specialist and Meghan Quigley Graham the Learning and Teaching Specialist from the Portland Art Museum shared a useful acronym that they use to try to achieve this goal, WUVE: welcome, understood, valued, empowered. The Portland Art Museum incorporates those attributes while designing exhibits and activities to make their visitors feel more comfortable while there (Amy Freesun and Meghan Quigley Graham, personal communication, April 13, 2021). This finding expands upon the combined exhibit design criteria in Figure 4 in "Designing Museum Exhibits" section providing criteria for family-friendly exhibits. From this finding, we recommend the Smiley Cart have music, lights, and free activities available to visitors. Not only is it important for the Cart attendant to be welcoming, but the aesthetic of the cart needs to be welcoming as well by being bright, warming, and creative.

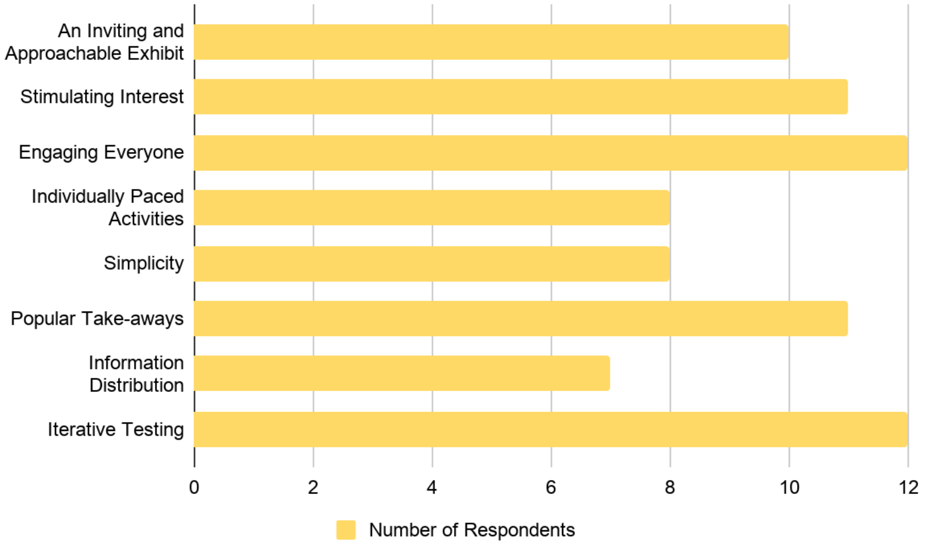

Figure 11: Summary of how many interviewees spoke to our findings.

In the survey we asked respondents to choose the top three things from a list of items that would most likely to draw them to an exhibit or a food truck. Each of 162 respondents selected their top three options producing 486 total selections. From the 486 selections, 278 selected their top tree as food, free stuff, and music, with activities a close fourth. By asking respondents what would draw them to an exhibit, we were able to design an exhibit that is welcoming and inviting. We ruled out having food in the Cart due to the handling, storing and giving out of food, would add many new requirements for the cart and is not in the radar of our sponsor.

Music, lights, and free activities will also help to stimulate the senses to immerse the audience in the Cart. During our research, 11 of our 12 interviewees stated that **exhibits that stimulate the visitor's interest and get them motivated are more successful in audience engagement.** We identified three ways to stimulate interest, (1) *creating personal connections*, (2) *present the information or activity in a way that appeals to multiple senses, such as touch, sight, sound, smell, and taste,* and (3) *teaching in a fun, engaging way*. The Director of Education and Visitor Services, Amy Consalvi and Laura Garrity-Arquitt, an Exhibits Manager at the Museum of Russian Icons explained that creating *personal connections* can make the audience curious about how an exhibit relates to them (Amy Consalvi and Laura Garrity-Arquitt personal communication, April 14, 2021). Bringing prior knowledge and experiences to the table allows the audience to connect to the activity and exhibit more. This makes visitors more likely to be excited and engaged. This is illustrated by the exhibit design criteria, “Relevant” in Figure 4 and is demonstrated in WHM’s golf course exhibit as the students incorporated Worcester facts and landmarks in the golf course designs. Additionally, presenting the information or activity in a way that *appeals to multiple senses, such as touch, sight, sound, smell, and taste* stimulates interest in the audience. The more senses the exhibit appeals to, the higher the chance the audience will get immersed into the exhibit. This finding of appealing to the senses, is not included in Figure 4 and provides a way to further engage the audience. Furthermore, Jeffery Forgeng, the Curator of the Higgins Armory Collection from the Worcester Art Museum, stated that getting the audience to fall in love with what they are learning is the best done by *teaching in a fun, engaging way* (Jeffery Forgeng personal communication, April 9, 2021). This finding is a combination between “Narrative” and “Challenge” in Figure 4.

The exhibit should be accessible to everyone. All 12 interviewees agreed that accessibility is important in exhibit design. **An accessible design caters to people who have *different heights, different styles of learning, different motor capabilities, and speak different languages*.** "Creating an environment where everyone is able to have a meaningful experience and receive the underlying message through one or more physical or mental pathways that meets their needs will lead to a more successful exhibit" (Eric Zago, personal communication, April 9, 2021). To achieve this the exhibit could have items/surfaces at *different heights* and have all the information be portrayed in many different ways to cater *non-english speakers* and *different learning styles*, such as pictures accompanying the instructions. While Elm Park has picnic tables available for use, other locations may not. Consequently, if there are visitors with *different motor capabilities*, we recommend attaching a foldable surface to the Cart or storing small tables for use with wheelchairs if no tables are available. This finding speaks to “Accessible” and “Multi-modal” in Figure 4. When considering the *different learning styles* all interviewees said that hands on, physical interactions are most popular for all ages. Similarly, 110 out of 162 survey participants, put physical interaction as one of their top three choices for how they best like to learn at museums. Consalvi and Garrity-Arquitt with the Museum of Russian Icons, Forgeng with the Worcester Art Museum, Brittany Liscord the Youth Coordinator at the Children's Museum & Theater of Maine, and Robert Kiihne, the Exhibit Director with the USS Constitution Museum all specifically spoke to *interacting with others*, and not just the exhibit, is also a crucial part of the exhibit itself to get more discussion and value from the experience. Both findings speak to “Participation,” “Multi-user,” and “Multi-sided” in Figure 4.

In addition to encouraging interaction, we found that **allowing visitors to go at their own pace increases enjoyment and engagement of the visitors with the exhibit.** In fact, 8 of the 12 interviewees spoke to the importance of having activities that allow people to go at their own pace. Having activities individually paced allows for people to have a deeper level of engagement, make personal connections with the exhibit/material and sparks more curiosity. A great example of this is an activity in the Arms and Armor exhibit at the Worcester Art Museum where people can try on helmets and armor and learn about what they are and how they were used. Visitors could stay as long or as little as they liked and the exhibit ended when they felt satisfied with the experience (Jeffrey Forgeng, personal communication, April 9, 2021). With this style of exhibit, museum goers can follow their interest, resulting in more knowledge being taken away because the audience is more engaged and interested. Comparatively, having a single pace activity where everyone does the activity at the same time at the same speed is not the best option for this type of activity. Visitors would not be able to find their own path and make the most out of the Smiley Cart if we tried to regulate their learning in this way. This finding expands the criteria for exhibit design presented in Figure 4.

Throughout our twelve interviews Robert Kiihne, Darcy Schwartz, Amy Freesun, Meghan Quigley Graham, Amy Consalvi, Laura Garrity-Arquitt, Brittany Liscord and Brindha Muniappan, the Senior Director of the Museum Experience at the Acton Discovery Museum spoke to **keeping things fun and simple for all parties involved is beneficial to an exhibit.** More specifically, keeping the exhibit easy yet interesting for the visitors, and keeping the set up for the activity simple for the facilitator will be optimizing both parties' time, especially in an

Interviewee	Position	Statement
Darcy Schwartz	President and Creative Program Director at ArtReach	Use QR codes, children know how to use them
Timmary Leary	Worcester Public School's Visual Art Liaison	QR codes are a way but offer multiple ways to access the information
Colleen Kelly	Worcester Public School's History and Social Sciences Library Media Specialist	Most secondary students have technology on them and can use QR codes.
Robert Kiihne	Executive Director at the U.S.S Constitution Museum	Use QR codes, everyone will have a phone.
Jeffery Forgeng	Curator of Arms and Armor at the Worcester Art Museum	QR codes are a very good Idea since it makes sure everyone will get the content on their phones.
Eric Zago	IT Administrator and Technical Special Projects Manager at the Ecotarium	Have a QR code that links to material, people take to QR codes right away.
Amy Freesun & Meghan Quigley Graham	Interpretation/Community Collaboration Specialist at the Portland Museum of Art & Learning Community Collaboration Departmen at Portland Museum of Art	QR codes in museums are a good idea.

Figure 12: Interviewee’s statements on QR Codes.

exhibit that travels. This finding expands the criteria for exhibit design as Figure 4 does not speak on simplicity. From this finding, we recommend keeping the Smiley Cart exhibit as simple as possible by first having an easy set up for the pin maker, bookmark station and I-Spy game (further detailed in the next section). Second, having the docent help with the pressing of the pins can make the activity run smoother and quicker as the machine could be harmful to children and the docent doesn’t have to teach every individual how to use the pin maker. Then third, by having all supplies ready to go, markers, crayons, pre-cut paper for pins and bookmarks, music preloaded, cleaning supplies. To ensure the Smiley Cart runs smoothly, we have provided WHM with a Smiley Cart Manual which can be seen in Appendix K. It contains a step-by-step procedure of making a pin, procedures of how to run the activities, and COVID-19 safety precautions.

One important aspect of exhibit design that all museum staff interviewed spoke to, was the importance of **iterative testing as a necessary, ongoing part of the design process** to improve the mobile exhibit. Kiihne, Freesun, and Quigley Graham all stated that they create multiple prototypes before development and make changes even after an exhibit has launched. We recommend WHM repeatedly test the mobile exhibit once it begins to operate. Interviewing, surveying, and observing the audience’s reactions every time the Smiley Cart is used is a great way to continue to improve the exhibit.

Interactive Activity Elements

During the 12 semi-structured interviews we conducted, we asked interviewees about the best ways to distribute material, as in any games or pieces of information that we would like our visitors to be able to learn. The overwhelming response was to **use quick response codes (QR code) and make the material accessible and allow people to take away the content.** The use of a QR code gives visitors access to material while engaging with the Cart and after they leave and allows for visitors to look further into the topic at a later time. The MMOTL’s mobile exhibit provides an example of effective use of a QR code on audience enjoyment of and engagement with the exhibit. Moreover, eight of the 12 interviewees spoke in favor of using QR codes to distribute information as it is an easy and accessible tool,

Takeaway	Who					
	Age 18-25 Survey Respondents	Age 26-35 Survey Respondents	Age 36-45 Survey Respondents	Age 46-60 Survey Respondents	Age 60+ Survey Respondents	Interviewees
Pin						1
Sticker						2
Bookmark			2			3
Mug	2	3	1			
Plush Toy	1	2				
Pencil/Pen						
Coloring Page				3	3	
Hats			3	1	1	
Stress Ball				2	2	
Sunglasses	3	1				

Figure 13: Comparative matrix of the top three takeaways for survey respondents by age group and interviewees (1 indicates the top choice, 2 indicates the middle choice, and 3 indicates the bottom choice).

shown in Figure 12. Interestingly, the same eight interviewees were unsupportive of using a tablet. Rather, they explained that the tablet wouldn't be as accessible, people wouldn't be able to take the content home, the docent would have to clean the tablet after every use, and glaring could be an issue. Forgeng, curator with the Worcester Art Museum stated that QR codes are a good idea to incorporate in our exhibit because everyone will have access to the information on their phones (Jeffrey Forgeng, personal communication, April 9, 2021). Additionally, Eric Zago, the IT Administrator at the EcoTarium voiced that the EcoTarium museum has started using QR codes due to the COVID-19 pandemic and have found that people took to them right away, however it is important to accommodate ones that are uncomfortable using QR codes and have a couple hard copies handy (Eric Zago, personal communication, April 9, 2021). Furthermore, Darcy Schwartz, the President of ArtReach and Robert Kiihne, The USS Constitution Museum's Director of Exhibits both spoke in favor of using QR codes and to the public's ability to access and use them (Darcy Schwartz, personal communication, April 1, 2021;Robert Kiihne, personal communication, April 6, 2021).

Likewise, 159 out of 162 survey respondents know what a QR code is and are comfortable using one. The three survey respondents who did not know about QR codes were all over the age of 60. In an attempt to accommodate this age gap, we held two focus groups in which five out of six children, aged 7-10, knew how to use QR Codes. Using a QR code to distribute the exhibits interactive activities and informative materials gives the best opportunity to reach multiple people at the same time while allowing them to go at their own pace and appealing to multiple senses.

In light of the groundbreaking QR code, we recommend playing the Smiley Face song while entering and leaving the event and provide a QR Code that links to the song, so visitors are able to listen to the song while enjoying the Cart if they would like. During our focus groups with the ArtReach students, we played the Smiley Face song for them and three out of six really enjoyed the song, while the three others were indifferent or disliked it. As a result of this, we recommend it would be best if the song wasn't continuously playing, but rather only to indicate the arrival and departing of the Smiley Cart and only when the audience would like to listen to it through the QR code. Due to the need for knowledge of QR codes and smartphones, we recommend the docents to be well versed in how to use QR codes and smartphones. The QR codes can be seen in Appendix I and O.

Based on the interviews, 162 survey responses and the Worcester Historical Museums proposal for feasible items, **we found that pins, bookmarks, and stickers would be the best fit as take away items**. In the interviews, we asked what their favorite takeaways from a family-friendly museum experience might be. We had 11 of the 12 interviewees all agree that these items would be some of the best for our cart: pins,

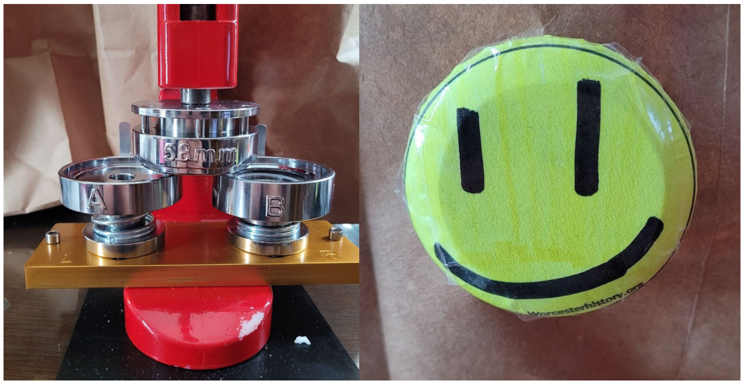

Figure 14: A picture of the pin maker and a Smiley pin made from it.

drawing/coloring sheets, stickers, and bookmarks. In the survey we asked participants to rank if they liked items on a scale from strongly agree to strongly disagree. We analyzed the data by determining the top three takeaways (1 being the most desired) from each demographic as seen in Figure 13. When we further analyzed the data as a whole seeing that hats, mugs and plush toys where the most desired takeaways.

Using the aforementioned findings, we recommend the following activities accompany the Smiley Cart: make-your-own Smiley Face pins (see Appendix L for a template of a pin), make-your-own bookmarks and stickers (see Appendix M and N for a template of the bookmark and sticker), in which one can draw or color their own design, a timeline of Harvey Ball's life that goes around the Cart (see Appendix J), and an I-Spy game. Figure 14 shows the pin maker and a Smiley pin that was made and Appendix H shows a cost-analysis of the recommended activities. All 12 interviewees liked the connection between Harvey Ball's pin and a pin-making activity and believed it would be a good way to learn more about Ball while having a fun, interactive experience. All of these activities provide multiple learning opportunities and learning styles for the audience and allows them to make their own creative space.

The I-Spy game can be available through a QR code, leading them to a PowerPoint page with a list of items to find and fun facts about those items. Figure 15 shows the I-Spy handout (see Appendix I for the list of items to find and the fun facts), which can laminated for visitors to circle the images with whiteboard markers. In this way, the handouts can be re-used by cleaning off the marker. Visitors will learn about Worcester and its history, while finding historical events from Worcester and local buildings and landmarks. To increase engagement, we recommend a Smiley Face sticker prize will be awarded to anyone who finds the Smiley Face in the I-Spy game.

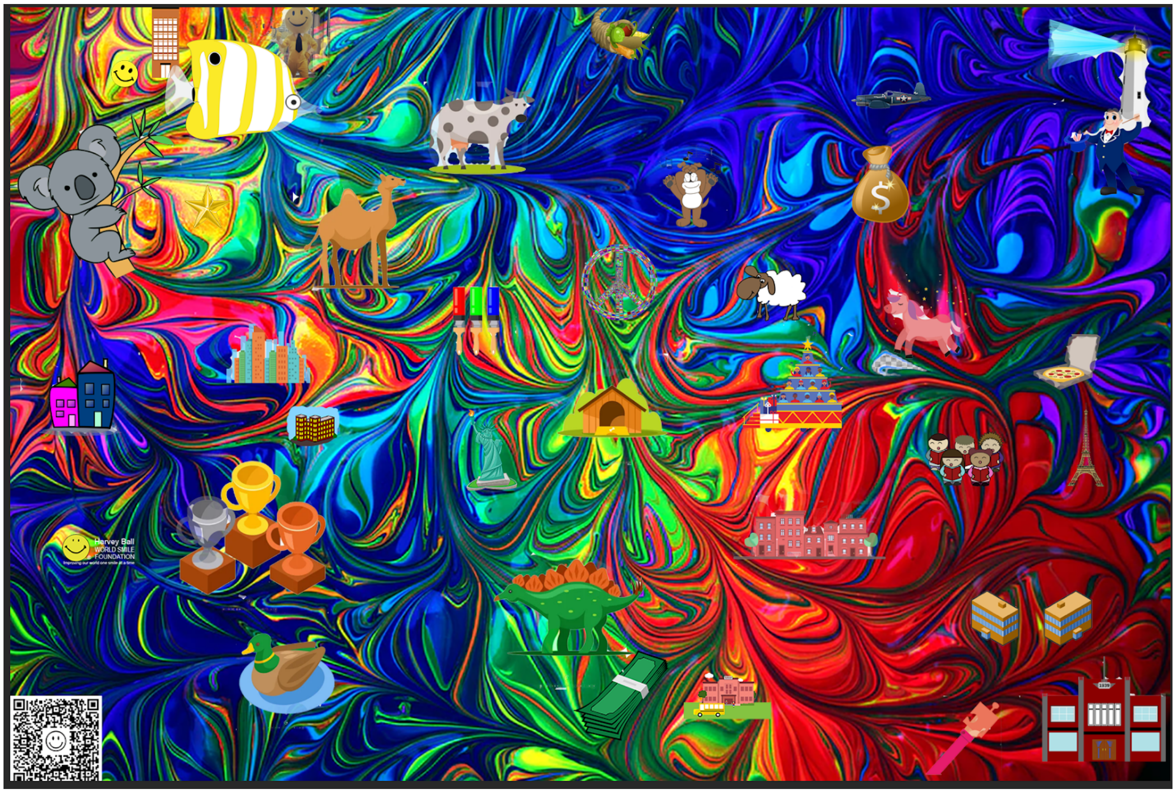

Figure 15: I-Spy game handout (see Appendix I for the QR code).

ADDITIONAL RECOMMENDATIONS AND CONCLUSION

Throughout our research, we uncovered some great ideas that we were unable to look into as they were either outside the scope of our project or difficult in the time we had. First, Colleen Kelly, Worcester Public School's History and Social Sciences Library Media Specialist brought up the idea of pairing the make-your-own-Smiley Face bookmarks with school book fairs. She explained that students who are there to buy books, would enjoy the bookfair even more if they were able to make their own bookmark (Colleen Kelly, personal communications, April 9, 2021). We recommend that WHM investigate this idea further.

As the Cart will be used in public areas and at events, we spoke with members of Worcester City Hall to confirm if there were any regulations WHM needed to follow or permits needed. After describing the project to City Hall, we found that in terms of regulations, there are no specific rules the Cart needs to follow as the activities are free. We recommend that before bringing the Cart to any park events, to check in with the Worcester City Hall beforehand as some parks may require a park event permit, it is a case by case basis.

We also recommend, if the Smiley Cart is being run at a special event, that WHM look into the possibility of having some of the more expensive take-aways, such as hats, sunglasses, plush-toys, and design-your-own mug, since those ranked highly in the survey. We believe these take-away items would be popular with all ages.

Lastly, we recommend WHM explore Mr. Wallace's idea of scratch cards. The scratch cards could have fun facts about Harvey Ball on them and or information about WHM on it, Along with a fun scratch off where the audience is able

Take-away Item	Location of the Cart
Bookmarks	Worcester Public School book fairs
Hats, sunglasses, plush-toys, and mugs	Special event (ex: The Harvey Ball)
Scratch cards	Anywhere (ex: Elm Park)

Figure 16: Possible take-away items and possible locations to implement them.

to win a coupon or prize to WHM. Coupons could be a 10% off the gift shop, 10% off the admissions price, free admission, and win a Smiley Face pin collectable. Due to time constraints, we were only able to provide the name of a company that could provide WHM with a custom scratch card. Figure 16 shows a summary of each possible take-away item and a possible location to implement them.

Bill Wallace and the Worcester Historical Museum continually strives to increase its connection with the community and spread the joys of the Smiley Face.

During our seven-week project, we were able to gain insight into exhibit design and opinions on attractive exhibits. After analyzing all the data, the key to having a successful exhibit is to be welcoming and engaging while having fun. This project was to help WHM spread Worcester history throughout the community and with the inclusion of our background and methods findings, we were able to provide the community with a fun way to learn about Worcester history. The Smiley Cart will bring smiles to the community for many years to come. As one sees the bright, yellow Cart rolling down the streets of Worcester, we hope they may think of Harvey Ball and his iconic Smiley Face that has brought joy to people all over the world.

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